February 8, 2012

Ontario Energy Board
2300 Yonge Street, Suite 2700
Toronto, Ontario
M4P 1E4

Attention: Ms. Kirsten Walli, Board Secretary

RE: EB-2012-0053 – Union Gas Limited – 2011 Demand Side Management Plan – New Measures for the 2011 Program Year

Dear Ms. Walli:

On September 9, 2010, the Ontario Energy Board (the "Board") issued its EB-2010-0055 Decision and Order approving Union Gas Limited's ("Union") 2011 Demand Side Management ("DSM") Plan. Union requests the approval of the Board of four new DSM measures for its 2011 program year.

Union has consulted with the 2011 Evaluation and Audit Committee (the "EAC") on all measures included in this filing for the 2011 program year. The consultation process concluded on December 15, 2011. Union and the 2011 EAC achieved complete consensus on the new measures and associated input assumptions.

Please find attached new measure substantiation documents in Attachment A. Attachment B contains Free Ridership values that were established for the new measures, Commercial – Non-Multifamily Low-Flow Showerheads, Bathroom and Kitchen Aerators, and Low Income – Low-Flow Showerheads.

Union requests an order of the Board approving the new measures as filed for the 2011 program year.

If you have any questions, please contact me at 519-436-4521.

Sincerely,

[Original signed by]

Marian Redford
Manager, Regulatory Initiatives

Cc: Crawford Smith (Torys)
EB-2010-0055 Intervenors

New 2011 DSM Measures

Low Flow Showerheads – Low Income

Low Flow Showerheads – Commercial

Low Flow Bathroom Aerators – Commercial

Low-Flow Kitchen Aerators – Commercial

Low-Flow Showerhead (1.25 GPM replacing 2.0 GPM, Low Income, Installed, per Household), UG

Revision #	Description/Comment	Date Revised

Efficient Equipment and Technologies Description

Low-flow Showerhead (1.25 GPM) – through Union Gas' HHC program. One showerhead distributed per ESK Kit.

Base Equipment and Technologies Description

2.0 GPM (Participants who previously received a 2.0gpm showerhead from Union)

Decision Type	Target Market(s)	End Use
Retrofit	Low Income	Water heating

Resource Savings Table

	Electricity and Other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (kWh)	Water (L)	($)	($)
1	33	0	11,584	3.79	0
2	33	0	11,584	0	0
3	33	0	11,584	0	0
4	33	0	11,584	0	0
5	33	0	11,584	0	0
6	33	0	11,584	0	0
7	33	0	11,584	0	0
8	33	0	11,584	0	0
9	33	0	11,584	0	0
10	33	0	11,584	0	0
TOTALS	330	**0**	**115,840**	**3.79**	**0**

Resource Savings Assumptions

Annual Natural Gas Savings — 33 m^3

Enbridge Gas commissioned a study by the SAS Institute (Canada)[1] to estimate natural gas savings for low-flow showerheads in Enbridge territory. Data was collected August 31, 2007 until August 31, 2009 for both treatment and control groups. Low flow showerheads were installed in treatment households between August 13, 2008 and October 30, 2008. There were 54 households with low-flow showerheads and 124 households without low-flow showerheads.

To calculate the gas savings, three different models were used to analyze the gas consumption data

1) a comparison made during the same time frame (post-installation) between a control set of households[2] and households that had them installed
2) a Pre & Post installation analysis on the same households, and
3) a complex time trend model analysis that factored in many household characteristics over the whole Pre & Post time period.

All three analyses agreed well with each other.[3]

[1] Rothman, Lorne, SAS® PHASE II Analysis for Enbridge Gas Distribution Inc.: Estimating the Impact of Low-Flow Showerhead Installation; April 5, 2010

[2] where no low-flow showerheads were ever installed

[3] Model 1 – a blended rate of 71.3 m3/yr (only models II and II provided bucketed savings estimates)
Model 2 – a blended rate of 67.4 m3/yr (45.4 m3/yr for 2 to 2.5 GPM bucket and 87.8 m3/yr for over 2.5 GPM), and

Three buckets for pre-existing showerheads were originally proposed. However, the lowest flow bucket (2.0 GPM or less) had too few observations and are rare in the population of households. The natural gas savings for the other two buckets are estimated to be as follows:

Baseline Flow rate (GPM)	Energy Efficient Flow Rate (GPM)	Change in GPM	Annual Natural Gas Savings (m^3)	Annual Natural Gas Savings (m^3 per GPM)
2.25[4]	1.25	1.0	46	46
3[5]	1.25	1.75	88	50

For base flow/efficient flow showerhead types not explicitly tested in the SAS study, gas savings have been extrapolated in the following manner:

1. The results of the SAS institute study indicate that gas savings increase at an increasing rate as the difference between efficient and base GPM increases.
2. Fitting a polynomial function with no intercept (no change in GPM = no gas savings) delivers the following function (where ΔGPM = Base GPM – Efficient GPM):

$$\text{Annual Gas Savings } (m^3) = 40.29 * \Delta GPM + 5.71 * \Delta GPM^2$$
$$= 40.29*(2.0-1.25) + 5.71*(2.0-1.25)^2$$
$$= 33$$

These savings values assume that 100% of household showering is reduced to 1.25 gpm. A survey determining the percentage of showering affected by the program should be used to adjust the year end program results.

Annual Electricity Savings	**0 kWh**
N/A	
Annual Water Savings	**11,584 L**

Since the SAS report did not look at water savings, Navigant Consulting proposes the following method for calculating resulting water savings:

Assumptions and inputs:

- As-used flow rate with base equipment: 1.78 GPM[6]
- Average household size: 3.1 persons[7]
- Showers per capita per day: 0.75[8]
- Average showering time per capita per day with base equipment: 7.37 minutes
- Average showering time per capita per day with new technology: 7.61 minutes[9]

Model 3 – a blended rate of 77.2 m3/yr (46.4 m3/yr for 2 to 2.5 GPM bucket and 87.9 m3/yr for over 2.5 GPM).

[4] Average of 2.0 GPM and 2.5 GPM

[5] Assumed average low flow showerhead which is greater than 2.5 GPM.

[6] As-used flow is calculated as a function of "full-on" or label flow: as-used flow = min{ 0.691+0.542*full-on flow, full-on flow}. Proctor, J. Gavelis, B. and Miller, B. *Savings and Showers: It's All in the Head*, (PGE) Home Energy Magazine, July/Aug 1994. Cited in Summit Blue (2008). .

[7] Summit Blue (2008).

[8] Ibid, based on data from: Resource Management Strategies, Inc., Regional Municipality of York Water Efficiency Master Plan Update, April 2007

[9] Relationship modeled as: Average shower length = 8.17 – 0.448 * as-used GPM. From Energy Center of Wisconsin Analysis of data from Resource Management Strategies, Inc., *Regional Municipality of York Water Efficiency Master Plan Update,* April 2007. Cited in Summit Blue (2008)

Annual water savings calculated as follows:

$$Savings = Ppl * Sh * 365 * \left(T_{base} * Fl_{base} - T_{eff} * Fl_{eff} \right)$$

Where:

Ppl = Number of people per household
Sh = Showers per capita per day
365 = Days per year
T_{base} = Showering time with base equipment (minutes)
T_{eff} = Showering time with efficient equipment (minutes)
Fl_{base} = As-used flow rate with base equipment (GPM)
Fl_{eff} = As-used flow rate with efficient equipment (GPM)

Savings = 3,060 gallons or 11,584 litres

Other Input Assumptions

Effective Useful Life (EUL)	**10 Years**
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).	
Incremental Costs	**$3.79**
As per utility program costs, bulk purchase of showerheads.	

[10] "Residential Measure Free Ridership And Inside Spillover Study - Final Report", Summit Blue Consulting, June 2008.

Low Flow Showerheads (1.25 GPM wall-mounted, 1.5 GPM handheld)

Commercial (Non Multi-Family) - Existing, UG

Description/Comment
Savings and Costs are shown per Showerhead.

Efficient Equipment and Technologies Description	
Low flow showerheads reduce water use and the energy required for water heating.	
University and College Dormitories	1.25 GPM
Hotels and Motels	1.25 GPM
Long Term Care and Retirement Residences	1.5 GPM handheld & 1.25 GPM
Other Commercial / Institutional	1.5 GPM handheld & 1.25 GPM

Base Equipment and Technologies Description
Average existing stock[1] – University and College Dormitories: 3.33 GPM rated (1.52 GPM As-Used) Hotels and Motels: 2.17 GPM rated (1.84 GPM As-Used) Long Term Care and Retirement Residences (Handheld): 2.5 GPM rated (1.52 GPM As-Used) Long Term Care and Retirement Residences (Non-Handheld): 3.25 GPM rated (3.22 As-Used)

Decision Type	Target Market(s)	End Use
Retrofit	University and College Dormitories, Hotels and Motels, Long Term Care and Retirement Residences, Other Commercial / Institutional.	Water Heating

Codes, Standards and Regulations

Ontario Building Code (2006)[2] requires showerheads to have a maximum flow rate of 2.5 GPM (9.5 L/min).

Resource Savings Table – University and College Dormitories

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	32	0	8,326	$3.79	$0.00
2	32	0	8,326	$0.00	$0.00
3	32	0	8,326	$0.00	$0.00
4	32	0	8,326	$0.00	$0.00

[1] The flow rates of average existing stock are based on primary research in Ontario conducted between July and October 2011. The research was conducted as part of a water use monitoring study commissioned by Union Gas: "Hot Water Conservation in Commercial / Institutional Buildings" by Caneta Research, 2011.

[2] Ontario Regulations 350/06, 2006 Building Code

5	32	0	8,326	$0.00	$0.00
6	32	0	8,326	$0.00	$0.00
7	32	0	8,326	$0.00	$0.00
8	32	0	8,326	$0.00	$0.00
9	32	0	8,326	$0.00	$0.00
10	32	0	8,326	$0.00	$0.00
Total	**320**	**0**	**83,260**	**$3.79**	**$0.00**

Resource Savings Table – Hotels and Motels

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	18	0	5,250	$3.79	$0.00
2	18	0	5,250	$0.00	$0.00
3	18	0	5,250	$0.00	$0.00
4	18	0	5,250	$0.00	$0.00
5	18	0	5,250	$0.00	$0.00
6	18	0	5,250	$0.00	$0.00
7	18	0	5,250	$0.00	$0.00
8	18	0	5,250	$0.00	$0.00
9	18	0	5,250	$0.00	$0.00
10	18	0	5,250	$0.00	$0.00
Total	**180**	**0**	**52,500**	**$3.79**	**$0.00**

Resource Savings Table – Long Term Care and Retirement Residences

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	24	0	6,526	$3.79	$0.00
2	24	0	6,526	$0.00	$0.00
3	24	0	6,526	$0.00	$0.00
4	24	0	6,526	$0.00	$0.00
5	24	0	6,526	$0.00	$0.00
6	24	0	6,526	$0.00	$0.00
7	24	0	6,526	$0.00	$0.00
8	24	0	6,526	$0.00	$0.00
9	24	0	6,526	$0.00	$0.00
10	24	0	6,526	$0.00	$0.00

Total	**240**	**0**	**65,260**	**$3.79**	**$0.00**

Resource Savings Table – Other Commercial / Institutional

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	24	0	6,700	$3.79	$0.00
2	24	0	6,700	$0.00	$0.00
3	24	0	6,700	$0.00	$0.00
4	24	0	6,700	$0.00	$0.00
5	24	0	6,700	$0.00	$0.00
6	24	0	6,700	$0.00	$0.00
7	24	0	6,700	$0.00	$0.00
8	24	0	6,700	$0.00	$0.00
9	24	0	6,700	$0.00	$0.00
10	24	0	6,700	$0.00	$0.00
Total	**240**	**0**	**67,000**	**$3.79**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**University and College Dormitories: 32 m^3 Hotels and Motels: 18 m^3 Long Term Care and Retirement Residences: 24 m^3 Other Commercial / Institutional: 24 m^3**	m^3/yr

Union Gas commissioned a study[3] by Caneta Research to estimate the natural gas savings for low-flow showerheads in Union Gas territory. The study included 3 University/College Dormitories, 3 Hotels/Motels, and 5 Long Term Care/Retirement Residences. Water flow measurements of individual existing showerheads were made over a one week period. The existing showerheads were replaced with low-flow showerheads, followed by another week of water flow monitoring. The data was collected between July and October, 2011.

The following variables were found through surveys of the participating buildings, water flow measurements, and calculations. Survey respondents were asked to estimate the seasonal variation of the building occupancy, which was used to adjust the daily average number of users per showerhead and the showers per capita per day variables. The pre-retrofit and post-retrofit data were analyzed to estimate the water and natural gas savings attributable to the low flow showerheads, as calculated below.

Variables	University and College Dormitories	Hotels and Motels	Long Term Care and Retirement Homes with Handheld	Long Term Care and Retirement Homes with Non-Handheld

[3] Study Report: "Hot Water Conservation in Commercial / Institutional Buildings" by Caneta Research, 2011.

			Showerheads	Showerheads
Number of Occupants per Showerhead[4], *Ppl*	2.77	1.29	11.30	1.42
Showers per Capita per Day[5], *Sh* (1/person/day)	0.41	0.90	0.11	0.40
Average Typical As-Used Flow Rate with Base Equipment[6], Fl_{base} (L/min)	5.74	6.96	5.75	12.17
Average Typical As-Used Flow Rate with New Technology[7], Fl_{eff} (L/min)	4.49	3.86	4.44	6.13
Average Typical Showering Time with Base Equipment[8], t_{base} (minutes)	9.27	5.42	5.07	6.70
Average Typical Showering Time with New Technology[9], t_{eff} (minutes)	7.42	6.57	3.66	8.05
Average Typical Showering Temperature with Base Equipment[10], T_{base} (°C)	36.86	37.58	36.41	35.08
Average Typical Showering Temperature with New Technology[11], T_{eff} (°C)	37.47	39.96	39.30	35.10

$$Annual\ Water\ Savings = PPl \times Sh \times 365\ (days/year) \times \left(t_{base} \times Fl_{base} - t_{eff} \times Fl_{eff}\right)$$
$$= 8{,}326\ (L/year)\ for\ University\ and\ College\ Dormitories$$
$$= 5{,}250\ (L/year)\ for\ Hotels\ and\ Motels$$
$$= 6{,}526\ (L/year)\ for\ Long\ Term\ Care\ and\ Retirement\ Homes$$[12]

$$Annual\ Water\ Savings\ for\ Commerical\ /\ Institutional\ Buildings = Average\ of\ Annual\ Water\ Savings\ for\ Univeristy\ and\ College\ Dormitories, Hotels\ and\ Motels,$$

[4] Obtained from surveys conducted during primary research, adjusted for seasonality.
[5] Calculated from monitored data collected during primary research.
[6] Calculated from monitored data collected during primary research.
[7] Calculated from monitored data collected during primary research.
[8] Calculated from monitored data collected during primary research.
[9] Calculated from monitored data collected during primary research.
[10] Calculated from monitored data collected during primary research.
[11] Calculated from monitored data collected during primary research.
[12] The expected proportions of showerheads used in Long Term Care and Retirement Homes in this program are 20% handheld and 80% non-handheld. The Annual Water Savings for handheld showerheads is 5,715 L/year. The Annual Water Savings for non-handheld showerheads is 6,728 L/year. Therefore, the Annual Water Savings for showerheads used in Long Term Care and Retirement Homes is 20% x 5,715 L/year + 80% x 6,728 L/year = 6,526 L/year.

$$and\ Long\ Term\ Care\ and\ Retirement\ Homes$$
$$= 6{,}700\ (L/year)\ for\ Other\ Commercial\ /\ Institutional\ Buildings$$

The natural gas saved is calculated based on the following factors:
Yearly annual water savings: see above calculation
Domestic cold water temperature: 9.33 °C[13]
Standard natural gas water heater efficiency: 78%[14]
Heat capacity of water: 4.184 KJ/Kg°C
Heat content of natural gas: 37,230 kJ/m^3

$$Natural\ Gas\ Saving\ (m^3) = PPl \times Sh \times 365\ (day/year) \times \frac{4.184\ (kJ/kg\ °C)}{78\ (\%) \times 37230\ (kJ/m^3)} \times \left[t_{base} \times Fl_{base} \times \left(T_{base} - 9.33(°C)\right) - t_{eff} \times Fl_{eff} \times \left(T_{eff} - 9.33(°C)\right)\right]$$

$$= 32\ (m^3/year)\ for\ University\ and\ College\ Dormitories$$
$$= 18\ (m^3/year)\ for\ Hotels\ and\ Motels$$
$$= 24\ (m^3/year)\ for\ Long\ Term\ Care\ and\ Retirement\ Residences$$[15]

$$Natural\ Gas\ Savings\ for\ Commerical\ /\ Institutional\ Buildings$$
$$= Average\ of\ Natural\ Gas\ Savings\ for\ Univeristy\ and\ College\ Dormitories, Hotels\ and\ Motels,$$
$$and\ Long\ Term\ Care\ and\ Retirement\ Homes$$
$$= 24\ (m^3/year)\ for\ Other\ Commercial\ /\ Institutional\ Buildings$$

Annual Electricity Savings	**0**	KWh/yr
N/A		
Annual Water Savings	**University and College Dormitories: 8,326 L Hotels and Motels: 5,250 L Long Term Care and Retirement Residences: 6,526 L Other Commercial / Institutional Buildings: 6,700 L**	L/yr
Annual water savings were calculated in the Annual Natural Gas Savings section above.		

Other Input Assumptions

Effective Useful Life (EUL)	**10**	Years
Summit Blue (2008) suggests an EUL of 10 years based on a survey of five studies of showerheads in other jurisdictions (California – two studies, New England, Vermont, Arkansas).		
Incremental Cost	**$3.79**	$

[13] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.
[14] From Union Gas substantiation documents for Drain Water Heat Recovery Units.
[15] The expected proportions of showerheads used in Long Term Care and Retirement Homes in this program are 20% handheld and 80% non-handheld. The Annual Natural Gas Savings for handheld showerheads is 19 m^3/year. The Annual Gas Savings for non-handheld showerheads is 25 m^3/year. Therefore, the Annual Gas Savings for showerheads used in Long Term Care and Retirement Homes is 20% x 19 m^3/year + 80% x 25 m^3/year = 24 m^3/year.

As per utility program costs, bulk purchase of showerheads.

Low Flow Bathroom Faucet Aerators (1.0 GPM)

Commercial (Non Multi-Family) – Existing, UG

Description/Comment
Savings and Costs are shown per Faucet.

Efficient Equipment and Technologies Description
Low flow bathroom faucet aerators (1.0 GPM rated) reduce water use and the energy required for water heating.
Base Equipment and Technologies Description
Average existing stock[1] – University and College Dormitories: 1.97 GPM rated (1.1 GPM As-Used) Hotels and Motels: 1.85 GPM rated (0.97 GPM As-Used) Long Term Care and Retirement Residences: 1.83 GPM rated (0.96 GPM As-Used)

Decision Type	Target Market(s)	End Use
Retrofit	University and College Dormitories, Hotels and Motels, Long Term Care and Retirement Residences, Other Commercial / Institutional.	Water Heating

Codes, Standards and Regulations

Ontario Building Code (2006)[2] requires faucets to have a maximum flow rate of 2.2 GPM (8.35 L/min).

Resource Savings Table – University and College Dormitories

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	8	0	1,719	$0.59	$0.00
2	8	0	1,719	$0.00	$0.00
3	8	0	1,719	$0.00	$0.00
4	8	0	1,719	$0.00	$0.00
5	8	0	1,719	$0.00	$0.00
6	8	0	1,719	$0.00	$0.00
7	8	0	1,719	$0.00	$0.00
8	8	0	1,719	$0.00	$0.00

[1] The flow rates of average existing stock are based on primary research in Ontario conducted between July and October 2011. The research was conducted as part of a water use monitoring study commissioned by Union Gas: "Hot Water Conservation in Commercial / Institutional Buildings" by Caneta Research, 2011.

[2] Ontario Regulations 350/06, 2006 Building Code

9	8	0	1,719	$0.00	$0.00
10	8	0	1,719	$0.00	$0.00
Total	**80**	**0**	**17,190**	**$0.59**	**$0.00**

Resource Savings Table – Hotels and Motels

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	6	0	2,221	$0.59	$0.00
2	6	0	2,221	$0.00	$0.00
3	6	0	2,221	$0.00	$0.00
4	6	0	2,221	$0.00	$0.00
5	6	0	2,221	$0.00	$0.00
6	6	0	2,221	$0.00	$0.00
7	6	0	2,221	$0.00	$0.00
8	6	0	2,221	$0.00	$0.00
9	6	0	2,221	$0.00	$0.00
10	6	0	2,221	$0.00	$0.00
Total	**60**	**0**	**22,210**	**$0.59**	**$0.00**

Resource Savings Table – Long Term Care and Retirement Residences

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	10	0	2,254	$0.59	$0.00
2	10	0	2,254	$0.00	$0.00
3	10	0	2,254	$0.00	$0.00
4	10	0	2,254	$0.00	$0.00
5	10	0	2,254	$0.00	$0.00
6	10	0	2,254	$0.00	$0.00
7	10	0	2,254	$0.00	$0.00
8	10	0	2,254	$0.00	$0.00
9	10	0	2,254	$0.00	$0.00
10	10	0	2,254	$0.00	$0.00
Total	**100**	**0**	**22,540**	**$0.59**	**$0.00**

Resource Savings Table – Other Commercial / Institutional

Year (EUL=)	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure ($)	Equipment & O&M Costs of Base Measure ($)
	Natural Gas (m^3)	Electricity (KWh)	Water (L)		
1	8	0	2,065	$0.59	$0.00
2	8	0	2,065	$0.00	$0.00
3	8	0	2,065	$0.00	$0.00
4	8	0	2,065	$0.00	$0.00
5	8	0	2,065	$0.00	$0.00
6	8	0	2,065	$0.00	$0.00
7	8	0	2,065	$0.00	$0.00
8	8	0	2,065	$0.00	$0.00
9	8	0	2,065	$0.00	$0.00
10	8	0	2,065	$0.00	$0.00
Total	**100**	**0**	**20,650**	**$0.59**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	**University and College Dormitories: 8 m^3 Hotels and Motels: 6 m^3 Long Term Care and Retirement Residences: 10 m^3 Other Commercial / Institutional: 8 m^3**	m^3/yr

Union Gas commissioned a study[3] by Caneta Research to estimate the natural gas savings for low-flow bathroom faucet aerators in Union Gas territory. The study included 3 University/College Dormitories, 3 Hotels/Motels, and 5 Long Term Care/Retirement Residences. Water flow measurements of individual existing faucets were made over a one week period. The low-flow faucet aerators were installed, followed by another week of water flow monitoring. The data was collected between July and October, 2011.

The following variables were found through surveys of the participating buildings, water flow measurements, and calculations. Survey respondents were asked to estimate the seasonal variation of the building occupancy, which was used to adjust the daily average number of users per faucet and the bathroom faucet uses per capita per day variables. The pre-retrofit and post-retrofit data were analyzed to estimate the water and natural gas savings attributable to the low flow aerators, as calculated below.

Variables	University and College Dormitories	Hotels and Motels	Long Term Care and Retirement Homes
Number of Occupants per Faucet[4], *Ppl*	3.79	1.36	5.97
Bathroom Faucet Uses per Capita per Day[5], *Fu* (1/person/day)	6.97	11.74	4.02
Average Typical As-Used Flow	4.25	3.69	3.63

[3] Study Report: "Hot Water Conservation in Commercial / Institutional Buildings" by Caneta Research, 2011.
[4] Obtained from surveys conducted during primary research, adjusted for seasonality.
[5] Calculated from monitored data collected during primary research.

Rate with Base Equipment[6], Fl_{base} (L/min)			
Average Typical As-Used Flow Rate with New Technology[7], Fl_{eff} (L/min)	2.98	1.84	2.35
Average Typical Faucet Use Time with Base Equipment[8], t_{base} (minutes)	0.19	0.18	0.29
Average Typical Faucet Use Time with New Technology[9], t_{eff} (minutes)	0.21	0.12	0.33
Average Typical Faucet Water Temperature[10], T_{supply} (°C)	42.23	27.55	39.82
Percentage of water that goes straight down drain[11], *Dr*	90%	90%	100%

$$Annual\ Water\ Savings$$
$$= PPl \times Fu\ \times\ 365\ (days/year)\ \times\ \left(t_{base} \times Fl_{base} - t_{eff} \times Fl_{eff}\right)\ \times Dr$$
$$= 1{,}719\ (L/year)\ for\ University\ and\ College\ Dormitories$$
$$= 2{,}221\ (L/year)\ for\ Hotels\ and\ Motels$$
$$= 2{,}254\ (L/year)\ for\ Long\ Term\ Care\ and\ Retirement\ Homes$$

$$Annual\ Water\ Savings\ for\ Commerical\ /\ Institutional\ Buildings$$
$$= Average\ of\ Annual\ Water\ Savings\ for\ Univeristy\ and\ College\ Dormitories, Hotels\ and\ Motels,\ and\ Long\ Term\ Care\ and\ Retirement\ Homes$$
$$= 2{,}065\ (L/year)\ for\ Other\ Commercial\ /\ Instituional\ Buildings$$

The natural gas saved is calculated based on the following factors:
Yearly annual water savings: see above calculation
Domestic Cold Water Temperature: 9.33 °C[12]
Standard Natural gas water heater efficiency: 78%[13]
Heat capacity of water: 4.184 KJ/Kg°C
Heat content of natural gas: 37,230 kJ/m^3

$$Natural\ Gas\ Saving\ (m^3)$$
$$=\ Annual\ Water\ Savings\ (L/year) \times \frac{4.184\ (kJ/kg\ °C)}{78\ (\%) \times\ 37230\ (kJ/m^3)} \times\ [T_{supply} - 9.33\ (°C)]$$

$$= 8\ (m^3/year)\ for\ University\ and\ College\ Dormitories$$
$$= 6\ (m^3/year)\ for\ Hotels\ and\ Motels$$

[6] Calculated from monitored data collected during primary research.
[7] Calculated from monitored data collected during primary research.
[8] Calculated from monitored data collected during primary research.
[9] Calculated from monitored data collected during primary research.
[10] Calculated from monitored data collected during primary research.
[11] Obtained from surveys conducted during primary research.
[12] Cited in the following as personal communication with City of Toronto Works Dept. VEIC, Comments on Navigant's Draft Gas Measure Characterizations, March 2009.
[13] From Union Gas substantiation documents for Drain Water Heat Recovery Units.

$= 10\ (m^3/year)\ for\ Long\ Term\ Care\ and\ Retirement\ Residences$

$Natural\ Gas\ Savings\ for\ Commerical\ /\ Institutional\ Buildings$
$= Average\ of\ Natural\ Gas\ Savings\ for\ Univeristy\ and\ College\ Dormitories, Hotels\ and\ Motels,$
$and\ Long\ Term\ Care\ and\ Retirement\ Homes$
$= 8\ (m^3/year)\ for\ Other\ Commercial\ /\ Instituional\ Buildings$

Annual Electricity Savings	**0**	KWh/yr
N/A		
Annual Water Savings	**University and College Dormitories: 1,719 L Hotels and Motels: 2,221 L Long Term Care and Retirement Residences: 2,254 L Other Commercial / Institutional: 2,065 L**	L/yr
Annual water savings were calculated in the Annual Natural Gas Savings section above.		

Other Input Assumptions

Effective Useful Life (EUL)	**10**	Years
As recommended by Navigant.		
Incremental Cost	**$0.59**	$
As per utility program costs.		

Low Flow Kitchen Faucet Aerators (1.5 GPM)

Commercial (non Multi-Family) – Existing, UG

Description/Comment
Savings and Costs are shown per Faucet.

Efficient Equipment and Technologies Description
Low flow kitchen faucet aerators (1.5 GPM) reduce water use and the energy required for water heating.
Base Equipment and Technologies Description
Average existing stock – (2.5 GPM)[1]

Decision Type	Target Market(s)	End Use
Retrofit	Commercial / Institutional (non-Multi-Family) RESTRICTION: Suites (such as in Hotel/Motels) and lunch or break rooms are NOT eligible due to relatively low expected hot water savings	Water Heating

Codes, Standards and Regulations

Ontario Building Code (2006)[2] requires faucets to have a maximum flow rate of 2.2 GPM (8.35 L/min).

Resource Savings Table

	Electricity and other Resource Savings			Equipment & O&M Costs of Conservation Measure	Equipment & O&M Costs of Base Measure
Year (EUL=)	Natural Gas (m^3)	Electricity (KWh)	Water (L)	($)	($)
1	16	0	5,377	$1.29	$0.00
2	16	0	5,377	$0.00	$0.00
3	16	0	5,377	$0.00	$0.00
4	16	0	5,377	$0.00	$0.00
5	16	0	5,377	$0.00	$0.00
6	16	0	5,377	$0.00	$0.00
7	16	0	5,377	$0.00	$0.00
8	16	0	5,377	$0.00	$0.00
9	16	0	5,377	$0.00	$0.00

[1] From on-site audit data. Resource Management Strategies, Inc. *Regional Municipality of York Water Efficiency Master Plan Update,* 2007. Cited in: Summit Blue, *Resource Savings Values in Selected Residential DSM Prescriptive Programs*, June 2008.
[2] Ontario Regulations 350/06, 2006 Building Code

10	16	0	5,377	$0.00	$0.00
Total	**160**	**0**	**53,770**	**$1.29**	**$0.00**

Resource Savings Assumptions

Annual Natural Gas Savings	16	m^3/yr

The savings are based on Multi-Family sector. In most Commercial/Institutional applications, kitchen faucet usage is expected to be higher based on the nature of C/I kitchen use (they are typically used by or on behalf of much larger groups of people than Multi-Family households).

Assumptions and inputs:

- Average faucet water temperature: 30 degC (86 degF)[3]
- Average water inlet temperature: 9.33 degC (48.8 degF)[4]
- Average water heater Recovery Efficiency: 0.76[5]

Annual gas savings calculated as follows:

$$Savings = W * 8.33 * (Tout - Tin) * \frac{1}{RE} * 10^{-6} * 27.8$$

Where:

W = Water savings (gallons)
8.33 = Energy content of water (Btu/gallon/degF)
T_{out} = Faucet water temperature (degF)
T_{in} = Water inlet temperature (degF)
RE = Water heater recovery efficiency
10^{-6} = Factor to convert Btu to MMBtu
27.8 = Factor to convert MMBtu to m3

Gas savings were determined to be 20% over base case:

$$Percent\ Savings = \frac{(G_{base} - G_{new})}{G_{base}}$$

Where:

G_{eff} = Annual natural gas use with efficient equipment, 64 m3

[3] Average of findings in two studies, adjusted for Toronto water inlet temperature. Mayer, P. W. et al, *Residential Indoor Water Conservation Study: Evaluation of High Efficiency Indoor Plumbing Fixture Retrofits in Single-Family Homes in East Bay Municipal Utility District Service Area,* 2003 and Skeel, T. and Hill, S. *Evaluation of Savings from Seattle's "Home Water Saver" Apartment/Condominium Program*, 1994. Both cited in: Summit Blue (2008).

[4] Cited in the following as personal communication with City of Toronto Works Dept.
VEIC, *Comments on Navigant's Draft Gas Measure Characterizations,* March 2009

[5] Assumption used by Energy Center of Wisconsin, citing GAMA, www.doa.state.wi.us/docs_view2.asp?docid=2249

G_{base} = Annual natural gas use with base equipment, 80 m3

Annual Electricity Savings	0	KWh/yr

N/A

Annual Water Savings	5,377	L/yr

The savings are based on Multi-Family sector. In most Commercial/Institutional applications, kitchen faucet usage is expected to be higher based on the nature of C/I kitchen use (they are typically used by or on behalf of much larger groups of people than Multi-Family households).

Assumptions and inputs:

- Average household size: 2.14 persons[6]
- Baseline faucet use (all faucets) per capita per day: 53 litres (14 gallons)[7]
- Kitchen faucet use as a percentage of total faucet use: 65%[8]
- Point estimate of quantity of water that goes straight down the drain: 50%[9]

Annual water savings calculated as follows:

$$Savings = Fu * Ppl * 365 * Ba * \left(\frac{Fl_{base} - Fl_{eff}}{Fl_{base}} \right) * Dr$$

Where:

Fu = Faucet use per capita (gallons)
Ppl = Number of people per household
365 = Days per year
Dr = Percentage of water that goes straight down the drain
Ki = Kitchen faucet use as a percentage of total faucet use
Fl_{base} = Flow rate of base equipment (GPM)
Fl_{eff} = Flow rate of efficient equipment (GPM)

Water savings was determined to be 20% over base case:

$$PercentSavings = \frac{\left(W_{base} - W_{eff}\right)}{W_{base}}$$

Where:

W_{eff} = Annual water use with efficient equipment: 21,509 litres (5,681gallons)

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[6] Summit Blue (2008) and Census 2006. To maintain consistency with Summit Blue number but to reflect the fact that apartments are generally occupied by fewer people than houses, the Summit Blue number was degraded by the ratio of the average number of inhabitants per apartment in an Ontario building over five stories (2) to the average number of inhabitants of a fully detached house in Ontario (2.9). Statistics Canada. No date. *Structural Type of Dwelling (10) and Household Size (9) for Occupied Private Dwellings of Canada, Provinces, Territories, Census Metropolitan Areas and Census Agglomerations, 2006 Census - 100% Data* (Table) *Census 2006.* Last updated Dec 6, 2008. http://www12.statcan.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=0&GC=99&GID=837983&GK=NA&GRP=1&IPS=&METH=0&ORDER=1&PID=89071&PTYPE=88971&RL=0&S=1&SUB=0&ShowAll=No&StartRow=1&Temporal=2006&Theme=69&VID=0&VNAMEE=&VNAMEF=

[7] Ibid.

[8] DeOreo, W. and P. Mayer, *The End Uses of Hot Water in Snigle Family Homes from Flow Trace Analysis*, 1999 cited in Summit Blue (2008).

[9] Summit Blue (2008).

W_{base}= Annual water use with base equipment: 26,887litres (7,101 gallons)

Other Input Assumptions

Effective Useful Life (EUL)	**10**	**Years**
The U.S. DOE assumes a 10 year life for faucet aerators.[10]		
Incremental Cost	**$1.29**	**$**
Average equipment cost based on utility bulk purchase order costs. This does not include installation costs.		

[10] U.S. Department of Energy, Federal Energy Management Program, *FEMP Designated Product: Lavatory Faucets* http://www1.eere.energy.gov/femp/procurement/eep_faucets.html

Attachment B

Free Ridership Values for New Measures

Measure	Building Segment	Value
Commercial, Non-Multifamily, Low Flow Showerheads	Existing	10%
Commercial, Non-Multifamily, Low Flow Bathroom Aerators	Existing	10%
Commercial, Non-Multifamily, Low Flow Kitchen Aerators	Existing	10%
Low Income, Low Flow 1.25 GPM Showerheads (2.0 GPM Basecase)	Low Income	1%